

ON THE SUPPOSED GLACIAL EPOCH IN AUSTRALIA.

BY CAPTAIN F. W. HUTTON, F.G.S.,

HON. MEM. LIN. SOC., OF N. S. WALES.

Several geologists have imagined that the glacial epoch, which overspread Europe and N. America in the pleistocene period, had its counterpart at the same time in the Southern Hemisphere. This northern glacial epoch is supposed, with great probability, to have been due in large part to the high eccentricity of the earth's orbit which occurred from 80,000 to 200,000 years ago; since which time the eccentricity has been diminishing. Reasons however have been repeatedly given by New Zealand Geologists for dissenting from the idea that the Southern Hemisphere has suffered a glacial epoch, and in my last papers on the subject, I pointed out that high eccentricity would not produce a severe antarctic climate, owing to the small quantity of land in this hemisphere which is not already covered with snow; but that high eccentricity might produce a pluvial or diluvial epoch. (1) These reasons I need not recapitulate; but quite recently the new hypothesis has been broached that the Southern Hemisphere has had a small glacial epoch of its own some 2,000 or 3,000 years ago. No attempt has been made to account for this remarkable episode. It cannot have been due to great geographical changes in the Antarctic Ocean, for that is disproved by the short time that has since elapsed, and by the number of endemic species, and even genera, of plants found in the Antarctic Islands. Neither can it have been due to any astronomical or cosmical cause, because then it would have affected the Northern Hemisphere as well. As this hypothesis has been started by such a distinguished zoologist

(1) N. Z. Journal of Science, Vol. II., p. 266, and Quar. Jour. Geol. Soc., Vol. 41, p. 213.

and mountaineer as Dr. von Lendenfeld, whose words must carry weight, it is necessary that both the observations on which it is founded and the inferences drawn from them should be carefully examined; for, if it really occurred, it must have been one of the most incomprehensible episodes in the history of the earth. It will, however, take very strong evidence to establish it.

EVIDENCE FOR THE SOUTHERN GLACIAL EPOCH.

1. During a recent exploration of the central part of the Australian Alps, Dr. von Lendenfeld discovered traces of ancient glaciers, and, on the strength of this, he asserts "that Australia also has passed through a glacial period." (1) This discovery is highly interesting, and I do not wish to deny the former existence of these glaciers; on the contrary I think them highly probable, but we must bear in mind that the only evidence for them at present is the occurrence of *roches moutonnées* and smoothed surfaces of *decomposing granite*, at a level of 5800 feet and upwards: it is expressly stated that no moraines have as yet been found. But although I do not wish to deny the former existence of these glaciers, it is necessary to point out that it by no means follows that they were caused by a glacial epoch; because they might equally well have been due to greater elevation combined with greater atmospheric moisture, and no evidence is given to show that elevation has not occurred.

2. The only other Australian evidence for a glacial epoch admitted by Dr. von Lendenfeld is the occurrence of granite erratics on the beach, near Adelaide, which were discovered, I believe, by Prof. R. Tate, and which Dr. von Lendenfeld says were probably "deposited on the beach by icebergs stranded there, which may have drifted to the south coast of Australia from the South Pole at the time it was cooler in the Southern Hemisphere than at present."

This is real evidence for a glacial epoch for, if true, it necessitates a colder climate, which the mountain glaciers do not.

(1) Proc. Lin. Soc. of New South Wales, Vol. X., p. 44.

Let us examine it. The granite composing these erratics has not been described, and I am not aware that any attempt has been made to trace their origin. Dr. von Lendenfeld suggests the South Pole, but I am afraid it will take a more arduous journey than the ascent of Mount Townsend to verify the existence of granite there. All the land that has been examined at present in that direction is volcanic ; and if ice-borne erratics had travelled from the antarctic continent to S. Australia we should expect to find them also in abundance in Tasmania, New Zealand, and the Antarctic Islands, and that some would be volcanic rocks, which is not the case. We must always distrust an attempt to explain an isolated phenomenon by means of a wide-spread cause. If these erratics had been derived from Tasmania or New Zealand, we should expect that most of them would be gneiss or schist, or sandstone ; while granite would be rare. Large granite blocks, brought down by ice, are found in Preservation Inlet in New Zealand, but this granite is a remarkable one, and a fragment of it could probably be recognised. From Australia itself the erratics could not have come *if they are ice-borne*, because Australia could not have been sufficiently glaciated to furnish icebergs.

But are these erratics so huge that we are necessarily shut up to the conclusion that they are ice-borne? I believe they are described as "small," and consequently they may perhaps have been conveyed to their present position by floating seaweed or by means of ascidians : or possibly they may have been ballast of a ship. I merely throw out these suggestions, for as I have not examined the locality I cannot judge of the evidence ; but the iceberg theory is such a very improbable explanation of the occurrence of erratics in the latitude of Jervis Bay, or the North Cape of New Zealand, that we must hesitate before accepting it as true.

3. In another and earlier paper on the same subject Dr. von Lendenfeld says "Von Haast has furnished a map of the glaciers of the cold period [of New Zealand] which shews that several of the ice streams at that period extended down to the sea. I had occasion to observe the characteristic scratches on the rocks in the

Sounds on the West Coast close to the water's edge which prove the correctness of Von Haast's views." (1) But Dr. von Haast's map only shows that the glaciers of the period *would* have extended into the sea *provided* the sea was then at its present position ; and I have several times pointed out that there is no evidence at all in favour of the idea that the glaciers reached the sea, but that on the contrary the land at that time must have stood at a much higher level than now. Consequently old moraines at present on the shore line do not at all prove that the time of the greatest extension of our glaciers was a cold period. The same remarks apply to Dr. von Lendenfeld's own observations on ice scratches (2).

4. At the Meeting of the Linnean Society of N. S. Wales held on the 27th of last May, Mr. Wilkinson exhibited a collection of recent shells obtained from an estuarine deposit near Newcastle in which was a specimen of *Siphonalia maxima* at present only found in Bass' Strait, and Dr. Cox considered that this sub-fossil tended to confirm the hypothesis that a colder climate prevailed in N. S. Wales at some not very remote period. Now *noscitur a sociis* is a very useful adage in palæontology, but unfortunately in this case a list of all the shells found in the deposit has not yet been published. If *S. maxima* is associated with other Tasmanian species most of which do not live now so far north as Newcastle, then this will be by far the most important evidence of a southern glacial epoch ever advanced. But if, on the contrary, it is associated with N. S. Wales shells, as appears to be the case ; then this new evidence will shew that in Tasmania it is a survival of a species once more widely spread, and will prove that Tasmania has *not* undergone a glacial epoch since *S. maxima* lived on its shores. I have not seen *S. maxima* but it appears to be the same as *Fusus subreflexus* Sowerby, in Darwin's Geological Observations in S. America ; a species which is also found in the Pareora System in New Zealand, and which I believe to be, at best, only a variety of *S. dilatata* of North New Zealand, Australia, and Japan. Certainly it by no means gives the idea of a cold loving form.

(1) Pro. Lin. Soc. of N. S. Wales, Vol. IV., p. 806.

(2) As ice scratches are very rare in the Sound it is a pity that Dr. von Lendenfeld has not given us the precise locality where he found them.

This is all the evidence of a glacial epoch in Australia, but before passing on to the next part of my subject there is one other point I must notice. Dr. von Lendenfeld has not correctly understood the argument against a southern glacial epoch derived from the fauna and flora of New Zealand; this however, is my own fault, for on referring to my paper, I find that I have not been sufficiently explicit on this head. He says, "Hutton is not inclined to believe that the glacial period in New Zealand was so severe as is generally believed, in consequence of the great abundance of animal life at the time. I must say that I do not see this at all" (l. c., p. 51.) But it is not on the great abundance of life at the time that I rely, but on the subtropical character of that life in the north, and especially on the local occurrence of warmth loving plants and animals in the south. For example I may note the occurrence of *Areca sapida* on Banks' Peninsula; of *Paryphanta Hochstetteri* in Nelson and Picton; of *Ranella leucostoma* and *Cassis pyrum* in Martin's Bay; and of *Triton Spengleri*, *Scalaria Zelebori*, *Cookia sulcata*, and others at Stewart Island. These are outliers, which have been isolated by a gradually cooling climate; the cooling being perhaps due to the shifting of winter in the Southern Hemisphere from perihelion into aphelion.

It appears therefore that while no attempt has been made to explain the difficulties which must be explained before we can believe that a glacial epoch has occurred in the Southern Hemisphere, the evidence brought forward in its favour is, to say the least, very defective.

DATE OF THE GLACIER EPOCH.

In New Zealand there are, as is well-known, ice-marks dating from the present day to some former period when the glaciers were at their greatest extent, and for many years New Zealand geologists have been accustomed to call this latter time the *glacier* epoch of New Zealand in order to distinguish it from a *glacial* epoch, which term implies a considerable reduction of temperature. The term glacier epoch does not imply any hypothesis as to the cause of the glaciers; but all New Zealand geologists, whatever views

they may hold as to the cause, are of opinion that the *glacier* epoch was long anterior to the *glacial* epoch of Europe and N. America. (1)

Dr. von. Lendenfeld, however, has come to the remarkable conclusion that the glacier epoch in New Zealand "has not been more remote than two or three thousand years. (2) He bases this conclusion on observations he has made on the deltas at the mouths of the streams that run into the Sounds on the West Coast of Otago. "Scarcely," he says, "do we find a small delta sent up between the rocks at the mouths of the terminal rivers. This, together with the fact that the rivers bring down a great amount of rock and sand, shows that the Sounds cannot have existed long, for otherwise they would necessarily have been filled up more or less by the material which is continually being deposited at the bottom of their still waters." Unfortunately, Dr. von Lendenfeld does not give us any information as to which of the Sounds he has examined, so that it is impossible to test his statement in any particular case. I have myself only examined the heads of the following Sounds—Milford, Bligh, Bradshaw, and Preservation—so that my observations are not very extended, but so far as they go, they are at variance with those of Dr. von Lendenfeld. All these Sounds are shallow near their heads and afford good anchorage. Also, with the exception of Preservation, which is rocky, all have alluvial flats running for some distance up the valley at the end. In Milford the Cleddan Valley is not large, but that of the Arthur has considerable mud-flats and fluvatile deposits. The same is the case in the vallies at the heads of Bradshaw and Bligh Sounds, up which I went for some distance in 1874 prospecting for gold. Indeed I think that the fluvatile deposits are very considerable when we consider that none of the so-called "rivers" are more than ten or fifteen miles in length and often much less. These little streams are not to be compared to the Rhone where it runs into Lake Geneva, nor even to a small stream running from mountains exposed to great vicissitudes of climate; for the

(1) See N. Z. Journal of Science, Vol. II., p. 266, and Ann. Mag. of Nat. Hist., ser. 5. Vol. 15, p. 97.)

(2) Pro. Lin. Soc. of N. S. Wales, Vol. IX., p. 808.

climate in the Sounds, although moist, is remarkably equable all through the year; and, with the exception of Milford, the sides of the Sounds and the ranges between them, are covered with dense vegetation. On the eastern side of the mountains, where the rivers are longer, the process of filling up has gone on much more rapidly, and has reached a point far in advance of the rivers in Switzerland, although the latter are much larger. The rate of filling in of a lake or Sound does not depend so much on the height of the mountains surrounding it, as on the size of the catchment basin which it drains. The islands in the sounds are not *moutonnées*, and although some of the smaller ones are rounded, they show no sign of lee and strike sides. The precipices on either side of the sounds are also, in general, quite rough, and I only noticed two localities (both previously observed by Dr. Hector) where there was any appearance of polishing. One was in Milford Sound on the south side of the entrance to the "Narrows," the other near Deas Cove in Thompson Sound (1) I saw neither grooves nor striæ; but Dr. Hector noticed them in Thompson Sound and in the Cleddan Valley. (2) All this is very different from any glaciated district in Scotland, Wales, or Ireland, where nearly every rock tells the same tale; and, judging from published accounts, it is very different from the Fiords of Norway, the rocks of which are much the same as those of the West Coast Sounds of New Zealand. Yet that these sounds have at one time been occupied by ice is proved by the huge granite boulders lying on the sandstones and mudstones at Kisbee Bay in Preservation Inlet. But I need not reproduce the evidence in favour of the very ancient date of the great glacier epoch of New Zealand, (3) I will only say that it seems to me to be of much greater weight than the attempt of Dr. von Lendenfeld to show that detritus cannot have been poured into the West Coast Sounds for a longer period than two or three thousand years; for he does not know the original depth of the sounds nor the amount of *débris* that is annually brought down.

(1) Geology of Otago, Dunedin, 1875, p. 67.

(2) Geological Exploration of the West Coast, pp. 458 and 461.

(3) See N. Z. Journal of Science, Vol. II., p. 262, and Ann. and Mag. of Nat. Hist., Series 5, Vol. XV., p. 93.

Ten years ago I brought forward some reasons for thinking that a second, but smaller, glacier epoch occurred after the first had passed away. These reasons, however, were based entirely on some phenomena exhibited by the river channels in Otago, which seemed to imply a second elevation; (1) for of course in the South Island of New Zealand every upheaval must cause the glaciers to advance and subsidence must make them retreat. In my report just quoted I said "That all our lakes are not filled up is probably owing to the second advance of the glaciers which partially scooped them out again." But the evidence for this statement is very slight, and I have not been able to add to it during the last ten years.

If now I should be asked to what then do you attribute the ancient glaciers of the Australian Alps? I should answer, It is more probable that Mount Kosciusco once stood some three thousand feet higher than at present, when Tasmania was joined to Australia, and Central Australia was, perhaps, a vast lake; than that the temperature of the surrounding ocean should have been reduced ten degrees without any apparent cause, which is the only alternative.

NOTES AND EXHIBITS.

J. Brazier, C.M.Z.S., &c., exhibited specimens of the shells, dried ink-bags, and pigment of both sexes of *Sepia plangon*, Gray, from Port Jackson, also similar preparations of *Sepia Capensis*, from Bondi. He also exhibited mounted specimens of the valves and mantles of *Chiton spiniger* Sowb., from Port Denison, and of *Chiton petholatus*, from Port Jackson.

Mr. Trebeck exhibited specimens of fungi from Fiji, all belonging to the family of *Polyporus*; and a specimen of hard subcrystalline Tertiary limestone, from Eucla, West Australia, containing a fossil Pecten.

(1) Geology of Otago, pp. 84, 85, 88. and 94.